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Paper 60

# Aggregate Resources Inventory of Vespra Township Simcoe County Southern Ontario

By Staff of the Engineering and Terrain Geology Section
Ontario Geological Survey

1984

Ontario
Ministry of Natural Resources

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Minister

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Deputy Minister

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Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Natural Resources does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

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(back pocket)


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## ABSTRACT

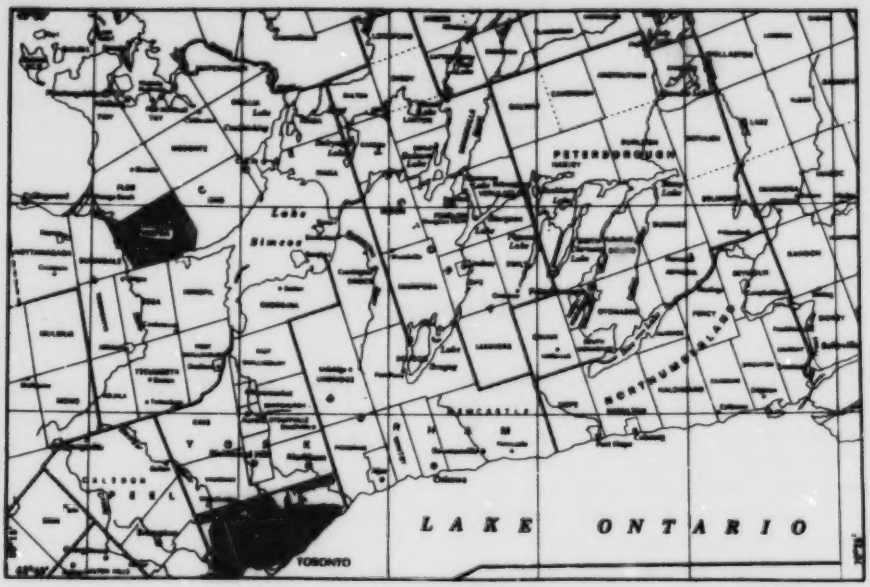


Figure 1 - Key Map Showing the Location of Vespra Township, Scale 1: 1 800 000.

This report includes both an inventory and evaluation of sand and gravel as well as bedrock resources in Vespra Township. The report is part of the Aggregate Resources Inventory Program for townships and municipalities designated under The Pits and Quarries Control Act, 1971.

In Vespra Township, two areas have been selected as Sand and Gravel Resource Areas of Primary Significance. Selected Resource Area 1 consists of numerous glaciolacustrine beach deposits related to the abandoned shorelines of glacial Lake Algonquin. Area 1 has an estimated 79 million tons (72 million tonnes) of sand and gravel acceptable for a wide range of crushed stone products. A glaciofluvial outwash deposit has been chosen as Selected Resource Area 2. This Area contains total possible resources of approximately 6 million tons (5 million tonnes) of sand and gravel. The parts of the resource areas which are available for extraction represent 5 percent of the total area occupied by sand and gravel deposits in the township, and 7 percent of the original tonnage.

In addition to these deposits, several others have been selected as Sand and Gravel Resource Areas of Secondary Significance. Although these deposits are not the "best" resources, they should be considered as part of the township's total aggregate supply.

Bedrock underlying Vespra Township consists of limestones and shales of the Bobcaygeon and Verulam Formations. Neither formation has been selected for possible resource protection, because of the great thickness of glacial sediments which overlie the bedrock surface.

Selected Resource Areas are not intended to be permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be wholly or partially reserved for extractive development and/or resource protection within the context of the official plan.

# AGGREGATE RESOURCES INVENTORY OF VESPRA TOWNSHIP[1]

BY
STAFF OF THE ENGINEERING
AND TERRAIN GEOLOGY SECTION

## INTRODUCTION

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1979, the total tonnage of mineral aggregates extracted was 144 million tons (131 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Ontario Ministry of Natural Resources 1980).

Although mineral aggregate deposits are plentiful in southern Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

**This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.**

The report includes an assessment of sand, gravel and crushed bedrock. The most recent information available has been used to prepare the reports. As new information becomes available, revisions may be necessary.

[1] Manuscript accepted for publication by Chief, Engineering and Terrain Geology Section, May 31, 1984.
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# PART I - INVENTORY METHODS

## FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References). Field methods included the examination of natural and man-made exposures of granular material. Most observations were made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites included estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations were also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, test pitting, soil probing and hand-augering techniques were used to assess subsurface materials. Airphotos at various scales were used to determine the continuity of deposits, especially in areas of limited subsurface information.

Deposits with potential for further extractive development or those where existing data are scarce, were studied in greater detail. Representative layers in these deposits were sampled in 25- to 100-pound (11 to 45 kg) units either from existing pit faces or from test pits dug by backhoe. The samples were analysed for grain size distribution and in some cases for petrographic assemblage. Analyses were performed by the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications. In areas of limited subsurface exposure, drilling using a powered hollow stem auger was undertaken. The stratigraphic sections in these test holes are described in drill logs included in the report as Table 7. In some cases samples taken during the course of the drilling were analysed to determine grain size distribution. The symbols for and locations of test hole sites are noted on Map 1.

In the office, the pit and field sample data were supplemented by information on file with the Soils and Aggregates Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The location, size, and depth of extraction of pits licenced under The Pits and Quarries Control Act, 1971 were obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above named groups in the compilation of inventory data is gratefully ackr.owledged.

Water well records, held by the Ontario Ministry of the Environment, were used in some areas to corroborate thickness estimates, or to indicate the presence of buried granular material. These records were used only in conjunction with other evidence. Soil reports published by the Ontario Ministry of Agriculture and Food were also consulted in order to supply additional information in areas with limited data. Topographic maps of the National Topographic System, at a scale of 1:50 000, were used as a compilation base for the field and office data. The information was then transferred to a township base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

## RESOURCE TONNAGE CALCULATION TECHNIQUES

### SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data

such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) in extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

*Tonnage = Area x Thickness x Density Factor*

Tonnage calculated in this manner must be considered only as an estimate. Furthermore, such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 represent only those parts of the deposit lying outside licenced areas (Column 2). Two successive subtractions are made from the unlicenced area. Column 3 accounts for the number of acres unavailable due to the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas lying outside of licenced properties that have previously been extracted (e.g. wayside pits are included in this category). The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multiplied by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

### BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of favorable bedrock formations overlain by less than 50 feet (15 m) of unconsolidated overburden is determined from bedrock geology maps, drift thickness and bedrock topography maps and from the interpretation of water well records. The measured extent of such areas is then multiplied by the estimated workable thickness of the formation, based on stratigraphic analyses and on estimates of existing quarry faces in the unit. In some cases a standardized estimate of a workable thickness of 60 feet (18 m) is used. Volume estimates are then multiplied by 3600 (the estimated weight in tons of a one-foot (0.3 m) thick section of dolostone, one acre (0.4 ha) in extent, assuming a bulk density of 165 pounds per cubic foot (2649 kg per cubic metre)).

Resources of sandstone are calculated using a bulk density estimate of 146 pounds per cubic foot (2344 kg per cubic metre) or approximately 3200 tons per acre (7173 tonnes per hectare). Shale resources are calculated on the basis of a bulk density estimate of 150 pounds per cubic foot (2408 kg per cubic metre).

### UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel as well as bedrock-derived aggregates are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p. 7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

## PART II - DATA PRESENTATION AND INTERPRETATION

Three maps, each portraying a different aspect of the aggregate resources in the municipality, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resource Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources", shows the distribution of bedrock formations, the thickness of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

### MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

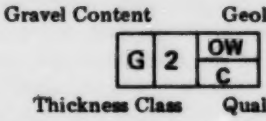
Map 1 is derived directly from the existing surficial geology maps of the area or from airphoto and field interpretation where surficial mapping is incomplete. It shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

The present level of extractive activity in the study area is indicated as follows. Those areas which are licenced for extraction under The Pits and Quarries Control Act, 1971 are shown by a solid outline and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner, location and licenced acreage of the pit, as well as the estimated face height and percentage gravel. A number of unlicenced pits (abandoned pits or wayside pits operating on demand under authority of a permit) are also identified and numbered on Map 1 and described in Table 2.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

#### DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for a given deposit. These components are illustrated by the following example:




This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate (greater than 4.75 mm) makes up less than 35 percent of the whole deposit. "G" indicates that the aggregate probably contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identify the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identify the main quality limitations that may be present in the deposit, as discussed in the next section.

#### TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution in deposits where samples were taken for analysis during field study. The data from which these symbols are derived has been plotted on grain size distribution graphs. The relative amounts of gravel, sand, silt, and clay in the sampled material are shown graphically by the sub-

division of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:

Test hole locations are shown on Map 1 by a solid drill hole symbol.

## MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resource areas are first delineated by geological boundaries and then classified into three levels of significance: primary; secondary; and tertiary. These areas are identified on Map 2 by different shading patterns. Each area of primary significance is assessed as to its probable relative value as a resource in the municipality and is given a deposit number which denotes its ranking order. All such deposits are shown by a dark shading on Map 2.

**Selected Sand and Gravel Resource Areas of primary significance are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.**

Deposits of secondary significance are not ranked numerically in this report, but are indicated by a light shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Although deposits of secondary significance are not considered to be the "best" resource areas in a municipality, they may contain large quantities of sand and gravel and should be considered an integral component of the aggregate supply of the municipality.

Areas of tertiary significance are indicated on the map by a dashed line but have no shading. They are neither rated nor considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the municipality is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

### SITE SPECIFIC CRITERIA

#### DEPOSIT SIZE

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6m) and containing more than 35 percent crushable gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

#### AGGREGATE QUALITY

The limitations of natural aggregates for various uses result from variations in the lithology of the particles composing the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S); fines (C); oversize (O); and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content (G or S) indi-

cates the suitability of aggregate for various uses. Deposits containing at least 35 percent gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (or high silt and clay content) may severely limit the potential use of an aggregate. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphaltic aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 4 inches (10 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

The other indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock formations determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high-quality uses such as concrete or structures. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either "C", "O", or "L" or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations. The Engineering Materials Office of the Ontario Ministry of Transportation and Communications has recently compiled a detailed assessment of aggregate suitability for selected areas in southern Ontario. This material has been consulted extensively in preparation of the inventory reports.

Analyses of unprocessed samples obtained from test holes and pits have been plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products — Granular Base Course A,B, and C; and Hot-Laid Asphaltic Sand Nos. 1, 2, 3, 4, 5, 6 and 8. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product.

### LOCATION AND SETTING

The location and setting of a resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of those natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on extractive development, such as thick overburden or high water table, are less valuable resource areas because of the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, power lines, and housing developments, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits and bedrock resource areas with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report but

readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

### REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain at roughly the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalities with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

### MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology, bedrock topography, drift thickness maps, water well data from the Ontario Ministry of the Environment, oil and gas well data from the Petroleum Resources Section (Ontario Ministry of Natural Resources), and from geotechnical test hole data from various sources. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Isolated outcrops are indicated by an "X". Three sets of contour lines delineate areas of less than 3 feet (1 m) of drift, areas of 3 to 25 feet (1 to 8 m) of drift, and areas of 25 to 50 feet (8 to 15 m) of drift. The extent of the areas of thin drift are shown by three shades. The darkest shade indicates areas where bedrock outcrops or is within 3 feet (1 m) of the ground surface. These areas constitute potential resource areas of primary significance because of their easy access. The medium shade indicates areas where drift cover is up to 25 feet (8 m) thick. Quarrying is possible in this depth of overburden and these also represent potential resource areas. The lightest shade indicates bedrock areas overlain by 25 to 50 feet (8 to 15 m) of overburden. These latter areas constitute resources which have extractive value only in specific circumstances. Outside of these delineated areas the bedrock can be assumed to be covered by more than 50 feet (15 m) of overburden, a depth generally considered to be too great to allow economic extraction (unless part of the overburden is composed of economically attractive sand and gravel deposits).

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the municipality. Those areas which are licenced for extraction under The Pits and Quarries Control Act, 1971 are shown by a solid outline and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location, and licenced acreage of the quarry and an estimate of face height. Unlicenced quarries (abandoned quarries or wayside quarries operating on demand under authority of a permit) are also identified and numbered on Map 3 and described in Table 5. One additional symbol appears on the map: an open dot indicates the location of a selected well which penetrates bedrock. The overburden thickness is shown in feet beside the open dot.

### SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and

Communications. The main characteristics and uses of the bedrock formations found in southern Ontario are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations of sufficient thickness to support quarry operations. Since vertical and lateral variations in bedrock units are much more gradual than in sand and gravel deposits, the quality and quantity of the resource is usually consistent over large areas.

Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

### SELECTED RESOURCE AREAS

Selection of Bedrock Resource Areas has been restricted to a single level of significance. Three factors support this approach. First, quality and quantity variations are gradual. Second, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and third, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The Selected Areas are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such a resource area may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

## PART III - ASSESSMENT OF AGGREGATE RESOURCES IN VESPRA TOWNSHIP

### LOCATION AND POPULATION

Vespra Township occupies an area of 65,016 acres (26 312 ha) in central Simcoe County. The township is shown on portions of the Barrie (31 D/5) and Orr Lake (31 D/12) map sheets of the National Topographic System at a scale of 1:50 000. The township is bounded by Oro Township to the east, Sunnidale Township to the west, Flos Township to the north and Essa and Innisfil Townships to the south.

The City of Barrie is located to the southeast of the township, and is the main regional trade and retail centre. In 1982 Barrie's population was 44 111, an increase of approximately 55 percent since 1972 (Ontario Ministry of Municipal Affairs and Housing 1983; Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974).

Other village communities in the township include Midhurst, Minesing, Anten Mills and Dalston. The remainder of the population in the township is rural farm or rural residential.

The total population of Vespra Township, exclusive of the City of Barrie, was 5970 in 1982 and figures from previous years indicate that the population has increased by approximately 35 percent between 1972 and 1982 (Ontario Ministry of Municipal Affairs and Housing 1983; Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974). The continued growth of city and township population will increase the demand for mineral aggregates to satisfy road-building and construction needs.

Access to sand and gravel deposits within the township is provided by King's Highways 11, 26, 27, 90, 93 and 400 and by a network of paved and gravel-surfaced township roads. Tracks of the Canadian Pacific and Canadian National Railways also serve the township.

### PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The physiography and distribution of surficial materials including the sand and gravel deposits shown on Map 1 are largely the result of continental glaciation which took place some 23 000 to 10 000 years ago during the Great Ice Age (Late Wisconsinan Substage of the Pleistocene Epoch). The onset of this period was marked by lobes or submasses of the continental ice sheet advancing out of the Great Lakes basins, and covering southern Ontario. The remainder of this period was characterized by repeated advance, melting and retreat of the margins of these glacial lobes.

Vespra Township is situated within the Simcoe Lowlands and Simcoe Uplands physiographic regions. A detailed discussion of these areas and their land use activities can be found on pages 299-307 and 307-312 of The Physiography of Southern Ontario by L.J. Chapman and D.F. Putnam (1966).

Quaternary deposits in Vespra Township were deposited during or after the Port Bruce Stadial by the Lake Simcoe and Georgian Bay ice lobes (Burwasser 1974). These deposits consist mainly of glaciolacustrine, outwash and ice-contact materials as well as till. Recent Quaternary deposits of mud, muck and peat are found in poorly drained basins, the most significant being the Minesing Swamp, which covers the southwestern portion of the township.

Allenwood till (Burwasser, unpublished report) is the oldest glacial material found in the Simcoe Lowlands portion of the township. The till is exposed at the surface near Minesing and near the Flos/Vespra township boundary west of Edenvale. The material is described as a sandy silt till and its surface has moderate relief, partly subdued by results of glaciolacustrine action. This till was deposited by ice moving out of Georgian Bay from the north-northwest. Lacustrine silt and clayey silt cover much of the Minesing-Edenvale area of the township, thereby masking the underlying Allenwood till. The till has no economic potential as an aggregate resource because of its excessive fines content.

During the time of glacial retreat, the Simcoe Lowland area was flooded by glacial Lake Algonquin. The prolonged glaciolacustrine environment created the present-day, flat to gently rolling land surface, underlain by fine-grained sediments, including repeated sequences of sand, silt and clay (Deane 1950). Areas containing relatively clean lacustrine sand are indicated on Map 1. However, the fineness of gradation and

the shallow depths of the deposits limit their potential as significant local aggregate resources.

Shorebluffs of the main stages of glacial Lake Algonquin and its associated beach and nearshore deposits serve as a boundary between the Simcoe Uplands and Simcoe Lowlands. These lacustrine beach and bluff areas have been indicated as important sand and gravel resource areas. In particular, the large beach deposits extending from the southern boundary of the township to Midhurst Station represent a major aggregate resource area for Vespra Township. The material found in these deposits contains irregularly stratified, medium gravel with interstratified fine to coarse sand with pockets of good quality coarse gravel.

Adjacent to the Simcoe Lowlands, in the eastern half of the township, the Simcoe Uplands are represented by elevated areas reaching up to 1000 feet (305 m) above sea level (a.s.l.). These areas are frequently referred to as "Algonquin Islands" since they appear to have been islands in glacial Lake Algonquin. In Vespra Township, glacial deposits of till, ice-contact stratified drift and outwash materials make up these areas.

The till is exposed west of and above the Lake Algonquin shorebluffs near the City of Barrie municipal boundary. This till was deposited by a glacier advancing from the northeast (Burwasser and Boyd 1974). The till has very little value as an aggregate source. However, the till is underlain by a thick sequence of outwash sand in this area (Burwasser and Cairns 1974).

Outwash sand is also found in a substantial surficial deposit that is located immediately northwest of the City of Barrie and in a smaller deposit east of Anten Mills. These deposits contain clean aggregate which was deposited by fast-flowing meltwaters issuing from a receding ice margin. The sand and gravel in these deposits has good quality with areas of up to 20 to 40 percent stone content.

Ice-contact deposits of moderate areal extent are also situated in the vicinity of the City of Barrie. They resemble kame-like mounds and linear ridges which were deposited in the close proximity of decaying ice. Field data indicate that the aggregate in these deposits is lower in quality, because of the higher fines and low gravel content.

A much larger ice-contact deposit area dominates the northeast portion of the township. This deposit may contain additional large amounts of aggregate. The deposit is called the Bass Lake kame moraine (Deane 1950) and it occupies much of neighbouring Oro Township. A more detailed account of the glacial history and origin of this large deposit is given in Aggregate Resources Inventory Paper 65, Oro Township (Ontario Geological Survey 1984). In Vespra Township, this deposit is believed to contain large amounts of ice-contact stratified sand with pockets of gravel and loose sandy till. Further detailed investigation is required to delineate possible areas of coarse aggregate in the Vespra portion of the deposit.

## EXTRACTIVE ACTIVITY

At least twenty-five sand and gravel pits have been established in Vespra Township. Many of the pits have been developed in high quality Lake Algonquin shoreline deposits. Other pits have also been opened in outwash and ice-contact stratified drift deposits. Data from the Ontario Ministry of Transportation and Communications (M.T.C.) suggest that many of these sources possess pockets of coarse granular material acceptable for road-building and construction purposes (Deike 1980).

Many of the pits became inactive in 1973 when Vespra Township was designated under The Pits and Quarries Control Act, 1971. At the time of writing, records on file with the Huronia District Office of the Ontario Ministry of Natural Resources indicate that eight sand and gravel pits are licenced for extraction. The total area licenced for extraction in the township is 449 acres (182 ha).

Since the designation of Vespra Township, records of the total annual production from all licenced sources have been maintained by the Huronia District Office. The average annual production over the seven-year period from 1975 to 1981 is estimated to have been 405,000 tons (367 000 tonnes).

## SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 1 illustrates the occurrence of sand and gravel deposits in Vespra Township. The total area occupied by these deposits is approximately 30,500 acres (12 300 ha), or 47 percent of the

total area of the township. The deposits contain possible resources of 1170 million tons (1060 million tonnes). However, much of this material has limited potential for use as road-building or construction aggregate.

Map 2 illustrates the Selected Sand and Gravel Resource Areas. The Primary Resource Areas include glaciolacustrine beach deposits and a glaciofluvial outwash gravel deposit. The Selected Areas of Primary Significance have a total area of 2800 acres (1130 ha), exclusive of licenced properties. Cultural constraints and previous extraction reduce the area presently available for extractive development to 1440 acres (580 ha). The total available sand and gravel resources are estimated to be 85 million tons (77 million tonnes). The parts of the resource areas which are available for extraction represent 5 percent of the total area occupied by sand and gravel deposits in the township and 7 percent of the total resource tonnage.

The western portion of the Bass Lake kame moraine located north of Little Lake, and the large sand outwash deposit located immediately northwest of the City of Barrie have been selected at the secondary level of significance. All the remaining ice-contact stratified drift deposits in the township have also been selected as secondary deposits. Although these are not the "best" resources, they should be considered as part of the township's total aggregate supply.

### SELECTED SAND AND GRAVEL RESOURCE AREA 1

Selected Sand and Gravel Resource Area 1 consists of glaciolacustrine beach deposits related to the abandoned shoreline of glacial Lake Algonquin. The largest of the deposits is located between Midhurst Station and Essa and extends south into Essa Township. There has been a substantial history of sand and gravel extraction from these deposits over the years. Since the early 1940s, sand and gravel has been extracted from these deposits and much of the material has been depleted. Sand now predominates in some of the sources and the gravel generally remains in pockets (Deike 1980). Presently, three licenced properties (pit nos. 2, 4 and 6) and four unlicenced pits (pit nos. 10, 11, 13 and 24) are found within the Resource Area.

The licenced properties located in the Resource Area have faces ranging in height from 10 to 30 feet (3 to 9 m) and expose variable gravel contents ranging from 30 to 50 percent. Faces in these properties generally expose irregularly stratified, medium gravel with interstratified fine to coarse sand (Hewitt and Cowan 1969). Pockets of good quality coarse granular material were noted in pit no. 6.

Pit no. 4 has been given a moderate to moderate-high pit use rating (Deike 1980), as the aggregate is acceptable for Granular Base Course (G.B.C.) A and Hot-Laid (H.L.) No. 4 stone. Oversize material was also noted in this licenced property. Aggregate suitability data obtained from M.T.C. indicate that pit no. 6 is mainly a sand source, however, the aggregate from the existing pockets has been used for G.B.C. B and C and for select subgrade material. Blending is required in order to produce higher specification aggregate products.

The four unlicenced pits in the Selected Area expose faces ranging in height from 10 to 30 feet (3 to 9 m). The pits reveal moderately sorted, fine to coarse gravel overlying silty medium to coarse sand. Gravel contents in the pits range from 20 to 40 percent.

Pit no. 13 contains high quality aggregate which is acceptable for a full range of road-building and construction products with suitable processing and quality control. These products include G.B.C. A, B and C as well as H.L. 4 asphaltic aggregate. Blending is required to produce hot-laid sand. Data from M.T.C. indicate that aggregate from pit nos. 11 and 24 is acceptable for G.B.C. B and C and for select subgrade aggregate.

Resource Area 1 occupies 2480 acres (1000 ha), exclusive of licenced properties. Cultural constraints and previous extraction reduce the area presently available to 1270 acres (510 ha). Water well data from the Selected Area indicate a wide range of variety and thickness of aggregate. Assuming an average deposit thickness of 25 feet (8 m), sand and gravel resources are estimated to total 79 million tons (72 million tonnes).

The Resource Area is accessible by gravel-surfaced roads and King's Highways 26, 27 and 90. Single lines of the Canadian Pacific and Canadian National Railways are also located within close proximity to the deposits.

## SELECTED SAND AND GRAVEL RESOURCE AREA 2

Selected Sand and Gravel Resource Area 2 consists of a glaciofluvial outwash deposit situated east of Anten Mills. This outwash gravel has been modified by subsequent erosion by the waters of Lake Algonquin and in places the outwash is obscured (Burwasser and Cairns 1974). Presently, there is one licenced property (pit no. 8) situated in the northern extremity of the deposit.

Pit 8 exhibits a 10- to 15-foot (3 to 5 m) face of well rounded outwash gravel and interstratified coarse sand deposited by meltwaters flowing away from the ice margin of the receding glacier (Burwasser, unpublished report). In places, gravel content reaches 40 percent. This property has been given a moderate-high pit use rating and is capable of producing aggregate acceptable for a full range of road-building and construction products. However, sand control is required for the production of G.B.C. A and blending is necessary for hot-laid sand uses (Deike 1980).

Resource Area 2 occupies 300 acres (121 ha), exclusive of the licenced property. Cultural constraints and previous extraction reduce the area presently available to 170 acres (69 ha). Assuming an average deposit thickness of 15 feet (5 m), sand and gravel resources are estimated to total 6 million tons (5 million tonnes).

Road access to the Selected Area is excellent as King's Highway 27 crosses the eastern portion of the deposit.

## SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

Substantial areas of ice-contact stratified drift and outwash have been selected as Sand and Gravel Resource Areas of Secondary Significance. Many of these deposits contain large resources of sand and gravel that are suitable for many road-building and construction products. Consequently, these deposits provide alternate extractive sites to supplement those provided by the Primary Resource Areas.

The western part of the Bass Lake kame moraine, north of Little Lake has been selected for possible resource protection at the secondary level of significance. One licenced property (pit no. 7) and two unlicenced pits (pit nos. 9 and 12), containing pockets of crushable gravel, are located in the deposit. The material from these pockets is acceptable for a full range of road-building and construction products, but the sand requires blending for hot-laid use. The oversize must be either crushed or removed from pit no. 9 for the production of G.B.C. A (Deike 1980). A test hole (VE-TH-1) located south of Craighurst reveals depths of fine to coarse sand with traces of gravel. Subsurface investigation also indicates the presence of sandy silt till (Table 7; Figures 2a and 2b). Water well data throughout this portion of the kame moraine indicate considerable depths of sand and gravel as well as loose sandy till.

Further subsurface investigation in the western extension of the moraine could confirm the presence of additional pockets of crushable gravel. The aggregate may prove similar to that located in the eastern part of the moraine in Oro Township which possesses a very high potential for good quality coarse aggregate (Ontario Geological Survey 1984).

An extensive area of glaciofluvial outwash is located immediately northwest of the City of Barrie. Pit nos. 3 and 4 are found in the northwest extension of the deposit. The licenced properties are located in a topographic high that reaches a maximum elevation of approximately 975 to 1000 feet (297 to 305 m) a.s.l. Faces in these properties range in height from 10 to 50 feet (3 to 15 m) and stone contents vary between 20 and 40 percent. The southern face of pit no. 3 reveals approximately 10 feet (3 m) of sandy silt till, capping 30 to 40 feet (9 to 12 m) of well rounded, fine to medium gravel intermixed with fine to medium sand. Faces in pit no. 4 expose similar material. Pit no. 4 possesses a moderate to moderate-high pit use rating, as the material has been used for G.B.C. A and H.L. 4 stone (Deike 1980). Water well information in the vicinity of the licenced properties indicates considerable depths of sandy material. The likelihood of locating greater concentrations of crushable gravel in this deposit may be restricted to topographic high areas.

The remaining ice-contact stratified drift deposits in the township have also been selected at the secondary level. There are presently two licenced properties (pit nos. 5 and 6) and six unlicenced pits (pit nos. 17, 18, 19, 21, 22 and 23) located in the ice-contact deposits. All

properties have been given a low pit use rating (Deike 1980). Faces range in height from 10 to 45 feet (3 to 14 m) and have limited gravel contents. Many of these pits expose faces of poorly sorted, silty medium to coarse sand containing irregularly bedded, fine to coarse gravel. Although the aggregate from these deposits is generally not suitable for all uses, it is acceptable for select subgrade material and G.B.C. B and C. Sand control and blending of portions of the deposits are required in order to produce higher specification aggregate products (Deike 1980).

## BEDROCK GEOLOGY

The flat-lying Paleozoic bedrock that underlies Vespra Township consists of limestones and shales of the Bobcaygeon and Verulam Formations. These formations have a regional dip averaging about 25 feet to the mile (5 m to the kilometre) in a southwesterly direction (Liberty 1969, p. 8).

The Bobcaygeon Formation is the oldest Ordovician unit in Vespra Township. This formation occupies the eastern fringe of the township and consists of homogeneous, thin-bedded, fine-grained limestone with some shaly partings (Liberty 1969). The Upper and Middle Members of the formation are hard and compact and are erosion and abrasion resistant. They have been quarried elsewhere in the region for road-building and construction aggregate (Dolar-Mantuani 1975). However, a considerable thickness of drift has prevented any portion of the Bobcaygeon Formation from being selected as a resource area in Vespra Township.

The Bobcaygeon Formation is overlain by the Verulam Formation which underlies most of the township. The formation consists of approximately 200 feet (61 m) of fossiliferous, pure to impure limestone with interbedded shale (Liberty 1969, p. 52). This formation has been quarried in other parts of south-central Ontario to produce cement. The formation is not well suited for the production of road-building and construction aggregate because of low abrasion and freeze-thaw resistance and the presence of shaly interbeds (Dolar-Mantuani 1975). The Verulam Formation is covered by a considerable thickness of drift which has prevented the selection of any area underlain by the Verulam as a possible resource area unless, of course, the overlying drift is selected in its own right.

## SUMMARY

The sand and gravel deposits of Vespra Township were formed during the Great Ice Age. Several Lake Algonquin beach deposits and a glaciofluvial outwash deposit have been selected for possible resource protection and/or development at the primary level of significance. These deposits are generally capable of producing high quality coarse aggregate suitable for the production of granular base course materials and hot-mix asphalt paving mixes. Care should be taken to ensure the continuing availability of as much of these resource areas as possible. In addition, substantial areas of ice-contact stratified drift and outwash have been selected as secondary deposits. These secondary deposits are integral parts of the township's total aggregate supply.

Bedrock underlying Vespra Township consists of limestones and shales of the Bobcaygeon and Verulam Formations. Considerable thicknesses of drift have prevented any portion of these formations from being selected for resource protection, and the township must rely entirely on surficial deposits for its aggregate supply.

Enquiries regarding the Aggregate Resources Inventory of Vespra Township should be directed to the Ontario Ministry of Natural Resources either at the Huronia District Office, Midhurst, Ontario, L0L 1X0, (Tel. (705) 728-2900) or at the Central Region Office, 10670 Yonge Street, Richmond Hill, Ontario, L4C 3C9 (Tel. (416) 884-9203).

**TABLE 1 | TOTAL SAND AND GRAVEL RESOURCES, VESPRA TOWNSHIP***

| 1<br>CLASS NO. | 2<br>DEPOSIT TYPE<br>(see Appendix C) | 3<br>AREAL EXTENT<br>Acres<br>(Hectares) | 4<br>ORIGINAL TONNAGE<br>Millions of<br>Tons (Tonnes) |
|---|---|---|---|
| 1 | G-LB | 2440<br>(990) | 152<br>(138) |
| | S-IC | 6100<br>(2470) | 305<br>(275) |
| | S-LB | 35<br>(14) | 2<br>(2) |
| | S-LP | 2460<br>(1000) | 123<br>(112) |
| | S-OW | 4300<br>(1740) | 215<br>(195) |
| 2 | G-OW | 425<br>(172) | 16<br>(14) |
| | S-IC | 280<br>(113) | 10<br>(9) |
| | S-LB | 115<br>(46) | 4<br>(4) |
| | S-LP | 12,600<br>(5100) | 315<br>(285) |
| 3 | S-LD | 830<br>(335) | 17<br>(15) |
| 4 | S-OW | 700<br>(285) | 7<br>(6) |
| | | 30,500<br>(12 300) | 1170<br>(1060) |

N.B. Minor variations in tables are caused by rounding of data.

* Identified deposit areas within the City of Barrie and Springwater Provincial Park have been omitted on all tables.

**TABLE 2 | SAND AND GRAVEL PITS, VESPRA TOWNSHIP**

| 1<br>NO. | 2<br>MTC NO. | 3<br>OWNER/OPERATOR | 4<br>LOT | 5<br>CON. | 6<br>LICENCED AREAS<br>Acres<br>(Hectares) | 7<br>FACE HEIGHT<br>Feet<br>(Metres) | 8<br>% GRAVEL |
|---|---|---|---|---|---|---|---|
| LICENCED PITS | | | | | | | |
| 1 | B03-018 | Ken Keown &<br>Ted Corbett | Pt. SW¼<br>21 | 13 | 40<br>(16) | 20-25<br>(6-8) | 0 |
| 2 | – | Bentorswell<br>Construction Ltd. | Pt. E½<br>15 | 11 | 40<br>(16) | 25-30<br>(8-9) | 30-40 |
| 3 | – | Allan G. Cook Ltd. | Pt. W½<br>15 | 9 | 50<br>(20) | 30-50<br>(9-15) | 20-40<br>(variable) |
| 4 | B03-129 | Township of Vespra | SW½14<br>Pt. W½15 | 9 | 51<br>(21) | 10<br>(3) | 30-40<br>(variable) |
| 5 | B03-085 | Allan G. Cook Ltd. | E½21 | 8 | 16<br>(6) | 25-45<br>(8-14) | 10-20 |
| 6 | B3-157 | Midhurst Sand &<br>Gravel Enterprises Ltd. | E½13 | 6 | 50<br>(20) | 15-25<br>(5-8) | 40-50<br>(variable) |
| 7 | B03-100 | Cliff Varcoe Ltd. | 28 | 1 | 76<br>(31) | 50<br>(15) | variable |
| 8 | B03-136 | Allan G. Cook Ltd. | Pt.2 | 5 | 126<br>(51) | 10-15<br>(3-5) | 30-40 |
| | | | | | 449<br>(182) | | |
| UNLICENCED PITS* | | | | | | | |
| 9 | E3-127 | Pila<br>(H. Oades) | 32, 33 | 1 | | 10-20<br>(3-6) | 20-40<br>(variable) |
| 10 | – | Unknown | 31 | 2 | | 10-15<br>(3-5) | 30<br>(partially<br>overgrown) |
| 11 | B03-102 | Township of Vespra | 30 | 2 | | 10-15<br>(3-5) | 30-40<br>(variable)<br>(partially<br>overgrown) |
| 12 | B03-179 | Schoppel<br>(Slessor) | 27 | 1 | | 15-40<br>(5-12) | 20-40<br>(variable) |
| 13 | B-115 | Cliff Varcoe Ltd. | 13 | 6 | | 10-20<br>(3-6) | 30-40<br>(partially<br>overgrown) |

**TABLE 2 | SAND AND GRAVEL PITS, VESPRA TOWNSHIP**

| 1<br>NO. | 2<br>MTC NO. | 3<br>OWNER/OPERATOR | 4<br>LOT | 5<br>CON. | 6<br>LICENCED AREAS<br>Acres<br>(Hectares) | 7<br>FACE HEIGHT<br>Feet<br>(Metres) | 8<br>% GRAVEL |
|---|---|---|---|---|---|---|---|
| 14 | B-161 | E.S. McDiarmid | 15 | 4 | | 10<br>(3) | overgrown |
| 15 | B-119 | David Miller | 17 | 4 | | 12<br>(4) | overgrown |
| 16 | B-162 | Maw | 19 | 4 | | 10-12<br>(3-4) | overgrown |
| 17 | B03-072 | Schaeffer | 16 | 5 | | 10-20<br>(3-6) | 10<br>(partially overgrown) |
| 18 | B03-044 | Murphy | 20 | 8 | | 10<br>(3) | 0<br>(partially overgrown) |
| 19 | B-63 | Les Feynes<br>(Disher-Farrand) | 22 | 8 | | 10-15<br>(3-5) | 10-20<br>(partially overgrown) |
| 20 | B-121 | Hooper | 23 | 7 | | 10<br>(3) | 0 |
| 21 | B-177 | G. Moth | 21 | 9 | | 10-15<br>(3-5) | 10-20<br>(partially overgrown) |
| 22 | B-52 | R. Sass<br>(Cook Construction) | 21 | 9 | | 30-40<br>(9-12) | 10 |
| 23 | B-141 | Adair Wilson | 22 | 9 | | 10-15<br>(3-5) | 0 |
| 24 | B03-159 | Martin | 22 | 11 | | 20-30<br>(6-9) | 30-40 |
| 25 | B03-017 | J. Homes | 21 | 13 | | 20-25<br>(6-8) | 0 |

* Abandoned pits or wayside pits operating under authority of a permit.

**TABLE 3 | SELECTED SAND AND GRAVEL RESOURCE AREAS, VESPRA TOWNSHIP**

| 1<br>DEPOSIT NO. | 2<br>UNLICENCED AREA<br>Acres<br>(Hectares) | 3<br>CULTURAL SETBACKS<br>Acres<br>(Hectares) | 4<br>EXTRACTED AREA<br>Acres<br>(Hectares) | 5<br>AVAILABLE AREA<br>Acres<br>(Hectares) | 6<br>ESTIMATED DEPOSIT THICKNESS<br>Feet (Metres) | 7<br>AVAILABLE AGGREGATE<br>Millions of<br>Tons (Tonnes) |
|---|---|---|---|---|---|---|
| 1 | 2480<br>(1000) | 990<br>(400) | 220<br>(89) | 1270<br>(510) | 25<br>(8) | 79<br>(72) |
| 2 | 300<br>(121) | 120<br>(49) | 10<br>(4) | 170<br>(69) | 15<br>(5) | 6<br>(5) |
| | 2800<br>(1130) | 1110<br>(450) | 230<br>(93) | 1440<br>(580) | | 85<br>(77) |

TABLE 4 | TOTAL IDENTIFIED BEDROCK RESOURCES, VESPRA TOWNSHIP

| 1<br>DRIFT THICKNESS<br>Feet<br>(Metres) | 2<br>FORMATION | 3<br>ESTIMATED<br>DEPOSIT<br>THICKNESS<br>Feet (Metres) | 4<br>AREAL EXTENT<br>Acres<br>(Hectares) | 5<br>ORIGINAL TONNAGE<br>Millions of<br>Tons (Tonnes) |
|---|---|---|---|---|
| | | – NONE | | |

TABLE 5 | QUARRIES, VESPRA TOWNSHIP

| 1<br>NO. | 2<br>MTC NO. | 3<br>OWNER/OPERATOR | 4<br>LOT | 5<br>CON. | 6<br>LICENCED AREA<br>Acres (Hectares) | 7<br>FACE HEIGHT<br>Feet (Metres) |
|---|---|---|---|---|---|---|

– NONE –

TABLE 6 | SELECTED BEDROCK RESOURCE AREAS, VESPRA TOWNSHIP

| 1<br>**DEPOSIT NO.** | 2<br>**DEPTH OF OVERBURDEN**<br>Feet<br>(Metres) | 3<br>**UNLICENCED AREA**<br>Acres<br>(Hectares) | 4<br>**CULTURAL SETBACKS**<br>Acres<br>(Hectares) | 5<br>**EXTRACTED AREA**<br>Acres<br>(Hectares) | 6<br>**AVAILABLE AREA**<br>Acres<br>(Hectares) | 7<br>**ESTIMATED WORKABLE THICKNESS**<br>Feet (Metres) | 8<br>**AVAILABLE RESOURCES**<br>Millions of<br>Tons (Tonnes) |
|---|---|---|---|---|---|---|---|

– NONE –

## TABLE 7 | SUMMARY OF TEST HOLE DATA, VESPRA TOWNSHIP

Test Hole Number: VE-TH-1

Location: Lot 36, Conc. 1

Elevation: Approx. 925 feet (282 m) a.s.l.

Date: November 4, 1980

| DEPTH Feet (metres) | DESCRIPTION |
|---|---|
| 0-5 (0-1.5) | dirty coarse sand; clay and silt also present |
| 5-10 (1.5-3) | fine to medium sand and fine gravel; silt present |
| 10-15 (3-5) | sandy silty till encountered; medium sand and gravel present |
| 15-20 (5-6) | medium sand, good mortar sand; trace of stone and clay |
| 20-25 (6-8) | fine to medium sand |
| 25-30 (8-9) | medium sand |
| 30-35 (9-11) | coarser gravel encountered at 35 feet (11 m); medium sand present |
| 35-40 (11-12) | hit aquifer and hole terminated at 40 feet (12 m) |

Note: Sieve analysis (Map 1) for VE-TH-1a was sampled at 15 feet (5 m).

Sieve analysis (Map 1) for VE-TH-1b was sampled at 30 feet (9 m).

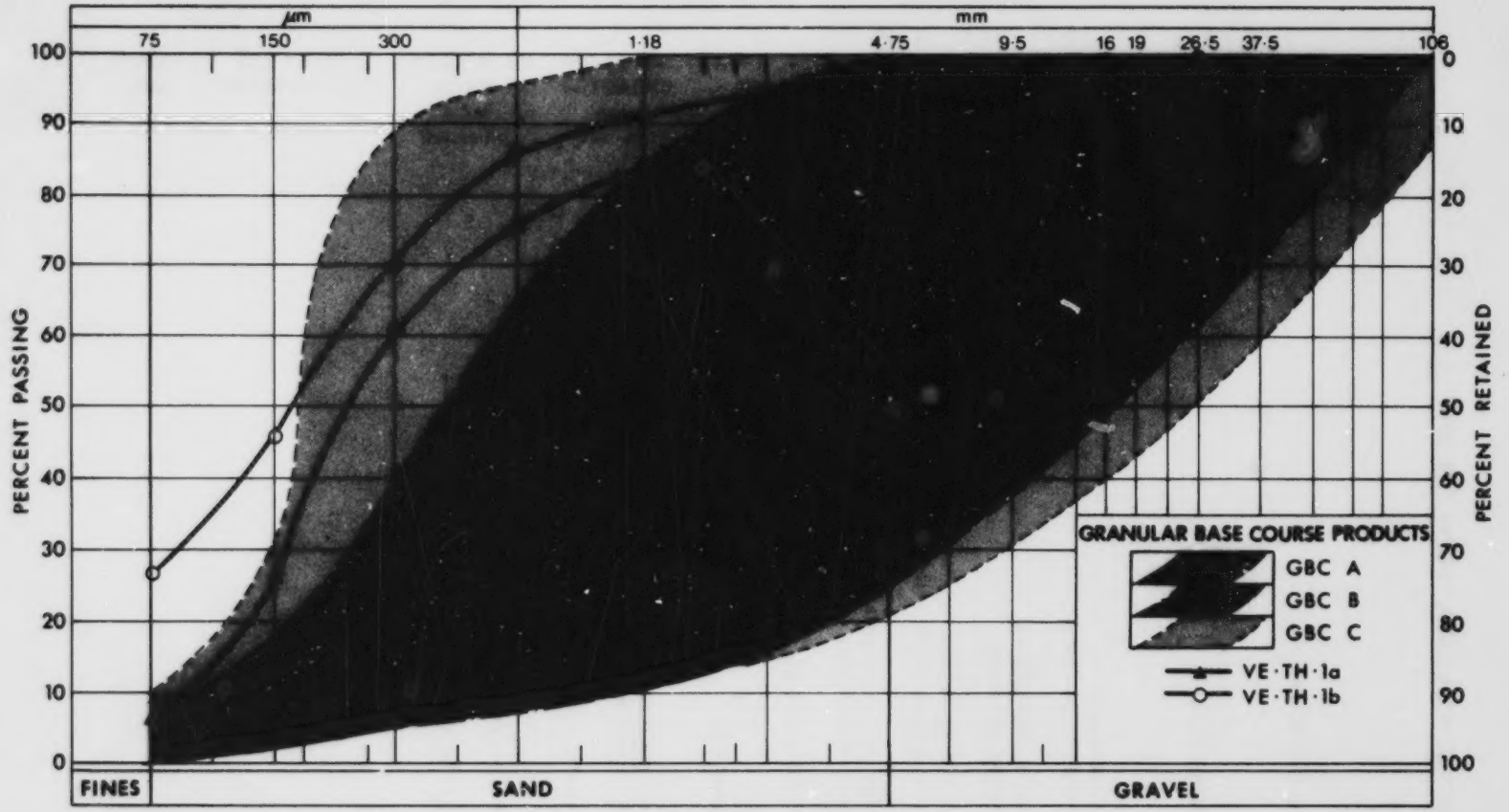



FIGURE 2a: AGGREGATE GRADING CURVES, VESPRA TOWNSHIP;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

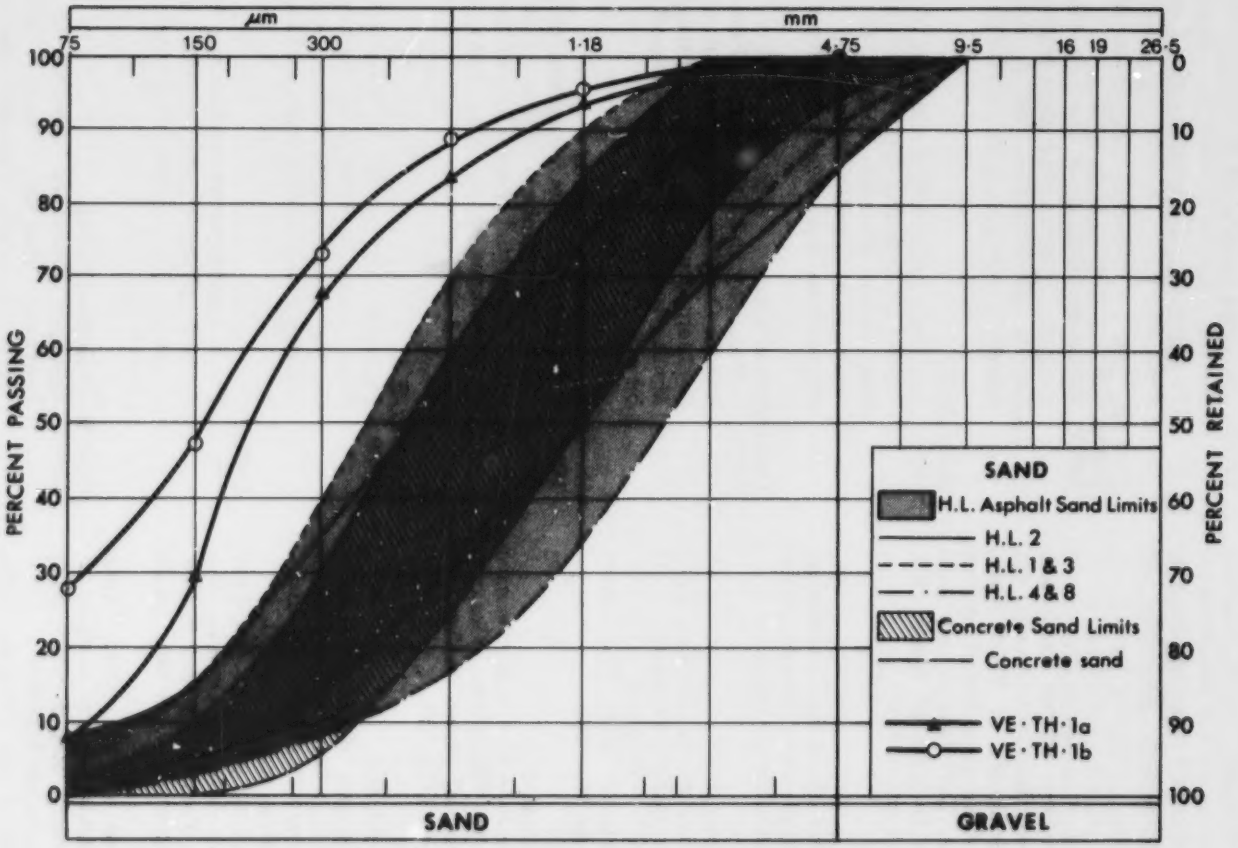



FIGURE 2b: AGGREGATE GRADING CURVES, VESPRA TOWNSHIP;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

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## APPENDIX B - GLOSSARY

### ABRASION RESISTANCE

Tests such as the Los Angeles Abrasion Test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

### ABSORPTION CAPACITY

Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

### AGGREGATE

Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

### ALKALI-AGGREGATE REACTION

A chemical reaction between the alkalies of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

### BLENDING

Required in cases of extreme coarseness, fineness or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

### CAMBRIAN

The first period of the Paleozoic Era, thought to have covered the time between 570 and 500 million years ago; the Cambrian precedes the Ordovician Period.

### CLAST

An individual constituent, grain or fragment of a sediment or rock, produced by the mechanical weathering of a larger rock mass. Synonyms include particle and fragment.

### CRUSHABLE AGGREGATE

Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

### DELETERIOUS LITHOLOGY

A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.

### DEVONIAN

A period of the geological past thought to have covered the span of time between 395 and 345 million years ago, following the Silurian Period. Rocks formed in the Devonian Period are among the youngest found in Ontario.

### DOLOSTONE

A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

### DRIFT

A general term for all unconsolidated rock debris transported from one place and deposited

in another; distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

### DRUMLIN

A low, smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were deposited beneath an advancing ice sheet, and were shaped by its flow.

### EOLIAN

Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

### FINES

A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

### GLACIAL LOBE

A tongue-like projection from the margin of the main mass of an ice cap or ice sheet. During the Pleistocene Epoch several lobes of the Laurentide continental ice sheet occupied the Great Lakes basins. These lobes advanced and retreated numerous times during the Pleistocene, producing the complex arrangement of glacial material and landforms found in southern Ontario.

### GRADATION

The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

| | |
|---|---|
| Boulder | more than 200 mm |
| Cobbles | 75-200 mm |
| Coarse Gravel | 26.5-75 mm |
| Fine Gravel | 4.75-26.5 mm |
| Coarse Sand | 2-4.75 mm |
| Medium Sand | 0.425-2 mm |
| Fine Sand | 0.075-0.425 mm |
| Silt, Clay | less than 0.075 mm |

### GRANULAR BASE COURSE

Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

### HOT-LAID (OR ASPHALTIC) AGGREGATE

Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3 and 4), or as binder course (H.L. 2, 6 and 8) used to bind the surface course to the underlying granular base course.

### LITHOLOGY

The description of rocks on the basis of such characteristics as color, structure, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

### MELTWATER CHANNEL

A drainage way, often terraced, produced by water flowing away from a melting glacier margin.

### ORDOVICIAN

An early period of the Paleozoic Era thought to have covered the span of time between 500 and 435 million years ago.

### PALEOZOIC ERA

One of the major divisions of the geologic time scale thought to have covered the time between 570 and 230 million years ago, the Paleozoic Era (or Ancient Life Era) is subdivided into six geologic periods, of which only four (Cambrian, Ordovician, Silurian and Devonian) can be recognized in southern Ontario.

### PETROGRAPHIC EXAMINATION

An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of the aggregate.

### PLEISTOCENE

An Epoch of the recent geological past including the time from approximately 1.8 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

### POSSIBLE RESOURCE

Reserve estimates based largely on broad knowledge of the geological character of the deposit and for which there are few, if any samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

### SHALE

A fine-grained, sedimentary rock formed by the consolidation of clay, silt or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone and mudstone.

### SILURIAN

An early period of the Paleozoic Era thought to have covered the time between 435 and 395 million years ago. The Silurian follows the Ordovician Period and precedes the Devonian Period.

### SOUNDNESS

The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

### TILL

Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

### WISCONSINAN

Pertaining to the last glacial period of the Pleistocene Epoch in North America. The Wisconsinan began approximately 100 000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of southern Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

## APPENDIX C - GEOLOGY OF SAND AND GRAVEL DEPOSITS

The type, distribution, and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100 000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

### GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

#### ICE-CONTACT TERRACES (ICT)

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous due to extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive due to the variability of the deposits both in terms of quality and grain size distribution.

#### KAMES (K)

Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good-quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the rare presence of excess fines (silt- and clay-sized particles).

#### ESKERS (E)

Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. Eskers vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout southern Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

#### UNDIFFERENTIATED ICE-CONTACT STRATIFIED DRIFT (IC)

This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits due to their lack of continuity and grain size variability. They are given a qualitative rating based on existing pit and other subsurface data.

#### OUTWASH (OW)

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. The deposits occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

#### ALLUVIUM (AL)

Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and it has generally low value due to the presence of excess silt- and clay-sized material. There are few large postglacial alluvium deposits in Ontario.

### GLACIOLACUSTRINE DEPOSITS

#### GLACIOLACUSTRINE BEACH DEPOSITS (LB)

These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the source material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

#### GLACIOLACUSTRINE DELTAS (LD)

These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

#### GLACIOLACUSTRINE PLAINS (LP)

The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources due to their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

### GLACIAL DEPOSITS

#### END MORAINES (EM)

These are belts of glacial drift deposited at, and parallel to, glacier margins. End moraines commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best resource areas within the moraine is usually poorly defined.

### EOLIAN DEPOSITS

#### WINDBLOWN DEPOSITS (WD)

Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in southern Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments almost always consist of fine to coarse sand and are usually well sorted. The probability of locating crushable aggregate in windblown deposits is very low.

## APPENDIX D - GEOLOGY OF BEDROCK DEPOSITS

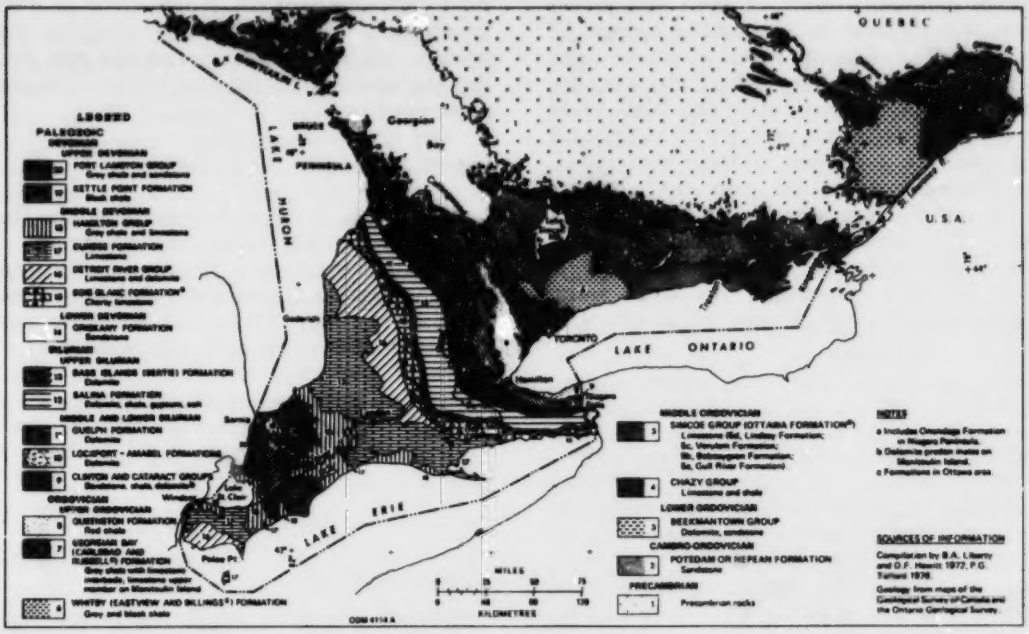



**Figure 3 - Bedrock Geology of Southern Ontario**

### BEDROCK SUITABLE FOR CRUSHED STONE PRODUCTS

#### BASS ISLANDS FORMATION (UPPER SILURIAN)

(Includes the Bertie Formation of the Niagara Peninsula) Composition: Medium- to massive-bedded, aphanitic, brown dolostone with shaly partings. Thickness: 35 to 60 feet (11 to 18m) near Hagersville. Uses: Quarried for crushed stone on the Niagara Peninsula at Fort Erie, Cayuga, Hagersville, and Dunville. Los Angeles Abrasion Test: 17-35% loss; Absorption: 1.4%. Shaly parts are unsuitable for aggregate due to high soundness losses.

#### BOBCAYGEON FORMATION (MIDDLE ORDOVICIAN)

Composition: Compact, homogeneous, medium to thin-bedded, fine-grained limestone with some argillaceous and shaly partings. Thickness: The lower unit is 40 to 72 feet (12 to 22 m) thick in the east and the remainder of the formation is 40 feet (12 m). Uses: Quarried at Kirkfield and Marysville for crushed stone. The Bobcaygeon Formation has consistently acceptable quality for granular base course materials and concrete.

#### BOIS BLANC FORMATION (LOWER-MIDDLE DEVONIAN)

Composition: Brownish grey, medium-crystalline, medium- to thin-bedded, cherty limestone, commonly fossiliferous. Limestone may be silty or sandy in places. Thickness: 9 to 200 feet (3 to 61 m). Uses: Quarried at Hagersville, Cayuga, and Port Colborne for crushed stone. High chert content makes much of the material unsuitable for concrete aggregate. Los Angeles Abrasion Test: 14-28% loss; Soundness Test: 4-10% loss; Absorption: 0.7-2.0%.

#### DUNDEE FORMATION (MIDDLE DEVONIAN)

Composition: Fine- to medium-crystalline, brownish grey, medium- to thick-bedded, dolomitic limestone with shaly partings, sandy layers, and chert in some areas. Thickness: 60 to 160 feet (18 to 49 m). Uses: Quarried near Port Dover and Pelee Island for crushed stone.

Used at St. Marys for portland cement. Los Angeles Abrasion Test: 22-32% loss; Absorption: 0-4%.

#### GULL RIVER FORMATION (MIDDLE ORDOVICIAN)

Composition: Member A: thin- to thick-bedded, interbedded, grey argillaceous limestone and buff to green dolostone with a maximum thickness of 60 feet (18 m). Members B and C are dense, aphanitic limestones with argillaceous dolostone interbeds. Uses: Quarried at Kirkfield, Victoria County, and Uhthoff for crushed stone. The product is generally fresh and compact with good cubic-shaped factor, low clay content, low absorption, and low soundness losses. Smooth particle surfaces may cause adhesion problems for asphalt. There is some alkali reactivity in a few of the layers.

#### LOCKPORT AND AMABEL FORMATIONS (MIDDLE SILURIAN)

Composition: Amabel Formation (Waterdown to the Bruce Peninsula): massive, fine-crystalline dolostone, with reef facies dolostone near Georgetown. Lockport Formation (lateral facies equivalent to the Amabel Formation from Waterdown to Niagara Falls): thin- to massive-bedded, fine- to medium-grained dolostone. Thickness: Amabel Formation: maximum observed thickness of 84 feet (26 m). Lockport Formation: up to 130 feet (40 m). Uses: The Lockport and Amabel Formations have been used to produce lime, crushed stone, concrete aggregate and building stone throughout their area of occurrence, and are a resource of provincial significance. Los Angeles Abrasion Test: 21-35% loss; Soundness Test: 2.0% loss; Absorption: 0.4-1.6%.

#### ONONDAGA FORMATION (MIDDLE DEVONIAN)

(Equivalent to the Detroit River Group, with a textural change) Composition: Edgecliff Member: medium-bedded, fine- to medium-grained, dark grey cherty limestone with an estimated thickness of 25 to 30 feet (8 to 9 m). Clarence Member: massive-bedded, dark grey brown, fine-grained, very cherty limestone having an estimated thickness of 26 feet (8 m). Moorehouse Member: medium-bedded, dark grey brown or purplish brown, fine- to coarse-grained, variably cherty limestone with an estimated thickness of 15 to 25 feet (5 to 8 m). Uses: Quarried for crushed stone on the Niagara Peninsula at Welland and Port Colborne. High chert content makes much of the material unsuitable for concrete aggregate.

#### OTTAWA FORMATION (MIDDLE ORDOVICIAN)

Composition: Lower Phase (Lowville and Pamela Beds): shale, some sandstone and dolostone. Thickness: 100 feet (30 m). Middle Phase (Hull, Rockland, and Leray Beds): pure, thick-bedded, crystalline limestone. Thickness: 150 feet (46 m) near Ottawa. Upper Phase (Cobourg and Sherman Fall Beds): pure and impure crystalline limestone with few to numerous shaly partings, 450 to 475 feet (137 to 145 m) thick near Ottawa. Uses: The Leray, Rockland, and Hull Beds have been quarried extensively for crushed stone and for building stone. In addition, the Hull Beds are an excellent source of lime for cement production and agricultural uses.

#### OXFORD FORMATION (LOWER ORDOVICIAN)

Composition: Medium- to thick-bedded, grey dolostone, with some shaly partings. Thickness: 240 feet (73 m). Uses: Quarried for crushed stone (road and concrete aggregate) at Ottawa, Brockville, and Smiths Falls.

### BEDROCK SUITABLE FOR LIME PRODUCTION AND OTHER CHEMICAL USES

#### DETROIT RIVER GROUP (MIDDLE DEVONIAN)

(Equivalent to the Onondaga Formation in the Niagara Peninsula, with a textural change) Composition: Near Beachville, the group consists of medium- to micro-crystalline, medium-bedded, high-purity limestone. It grades northwards near St. Marys to soft, evenly bedded, fine-grained dolostone with bituminous laminae. Massive, porous, reef facies material also occurs to the north (Formosa Reef Limestone). Thickness: 100 feet (30 m) at Beachville, 350 feet (107 m) at Clinton. Uses: The most important source of high-purity limestone in Ontario is the Lucas Formation of the Detroit River Group at Beachville. Detroit River limestone produces 80% of Ontario's cement. Its dolomitic reefal facies is also important for lime production to the north. It is generally unsuitable for crushed stone. The Anderdon Member of the Lucas Formation is quarried at Amherstburg for

crushed stone.

#### GRENVILLE MARBLE (PRECAMBRIAN)

Composition: Recrystallized white limestone and dolostone, fine- to coarse-grained, usually of high chemical purity. Uses: Lime production, but also in small amounts for terrazzo chips, poultry grit, decorative stone, and building stone.

#### GUELPH FORMATION (MIDDLE SILURIAN)

Composition: Aphanitic to medium-crystalline, thick-bedded, soft, porous dolostone, characterized in places by extensive vuggy, porous reefal facies dolostone of high chemical purity. The Guelph Formation and the underlying Amabel Formation have a combined thickness of 200 feet (61 m) on the Niagara Peninsula and more than 400 feet (122 m) on the Bruce Peninsula. Uses: The main use is for dolomitic lime in the construction industry. The formation is quarried near Hamilton and Guelph.

#### LINDSAY FORMATION (MIDDLE ORDOVICIAN)

Composition: Lower Member: fine-crystalline, rubbly, nodular-weathering limestone. Upper Member: grey calcareous claystone with shaly partings and bioclastic layers. The rock is "soft" and weathers to rubble. Both members are characterized by low dolomite content and by numerous clayey partings. Uses: Quarried at Picton, Ogden Point and Bowmanville for cement. The formation is generally unsuitable for crushed stone, concrete aggregate, or granular base course.

#### VERULAM FORMATION (MIDDLE ORDOVICIAN)

Composition: Fossiliferous, pure to argillaceous limestone and interbedded calcareous shale. The rock is not resistant to erosion and commonly weathers to rubble. Thickness: 200 to 300 feet (61 to 91 m). Uses: Quarried at Picton, Ogden Point, and Mara Township for cement. The formation is unsuitable for crushed stone due to clay impurities, many clayey interbeds, and low abrasion resistance, high soundness losses and poor freeze and thaw resistance.

### BEDROCK SUITABLE FOR BRICK AND TILE MANUFACTURE

#### GEORGIAN BAY FORMATION (UPPER ORDOVICIAN)

(Formerly known as the Meaford-Dundas and Blue Mountain shales in the Toronto and Bruce Peninsula areas) Composition: Soft, fissile, blue grey shale with limey or sandy lenses in a few places. Thickness: 640 feet (195 m) at Toronto. Uses: Several producers in Metro Toronto and Cooksville produce brick and structural tile. Lightweight aggregate is also produced at Streetsville by heat expansion of the shale.

#### HAMILTON GROUP (MIDDLE DEVONIAN)

Composition: Grey shale with interbeds of crystalline and cherty limestone. The group has six formations, but only the Arkona is of commercial value. It is a soft, light grey, calcareous shale which is plastic and easily worked when wet. Thickness: 80 to 300 feet (24 to 91 m). Uses: The Arkona Formation is extracted at Thedford and near Arkona for production of drainage tile and brick.

#### QUEENSTON FORMATION (UPPER ORDOVICIAN)

Composition: Red, thin- to thick-bedded, sandy to argillaceous shale with green mottling and banding. Thickness: 400 to 500 feet (122 to 152 m). Uses: There are several large shale quarries developed in the Queenston Formation in the Toronto-Hamilton region and one at Russell, near Ottawa. All produce brick for construction. The Queenston Formation is the most important source material for brick manufacture in the Province.

### BEDROCK SUITABLE FOR OTHER INDUSTRIAL PRODUCTS

#### NEPEAN (POTSDAM) FORMATION (CAMBRO-ORDOVICIAN)

Composition: Creamy, coarse-grained, silica sandstone. Uses: Quarried throughout its area of outcrop for building stone, decorative stone, abrasives, and for glass making.

#### SALINA FORMATION (UPPER SILURIAN)

Composition: Grey and red shale, brown dolomite, and, in places, salt, anhydrite, and gypsum.

The formation consists predominantly of evaporite deposits with up to eight members identified. Uses: Gypsum is mined at Hagersville, Caledonia, and Drumbo. Salt is mined at Goderich and is produced from brine wells at Amherstburg, Windsor, and Sarnia.

### WHITBY FORMATION (UPPER ORDOVICIAN)

(Formerly known as Collingwood Shale near Toronto) Composition: Brown to black fissile shale. Uses: Quarried at Bowmanville for use in cement production. Testing indicates that the Whitby Formation may produce satisfactory lightweight expanded aggregate.

## DEPOSIT SYMBOL

Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel Content is expressed as a percentage of gravel-sized material (i.e. material retained on the 4.75 mm sieve.). Thickness Class is based on potential aggregate tonnage per acre. Geological Type refers to geologic origin. Quality Indicator describes objectionable grain size and lithology.

### Gravel Content

| | |
|---|---|
| **G** | Greater than 35% gravel. |
| **S** | Less than 35% gravel. |

### Thickness Class

| Class | Average Thickness in feet (metres) | Tons per acre (Tonnes per hectare) |
|---|---|---|
| **1** | greater than 20 (> 6) | greater than 50,000 (> 112 000) |
| **2** | 10-20 (3-6) | 25,000-50,000 (56 000 - 112 000) |
| **3** | 5-10 (1.5-3) | 12,500 - 25,000 (28 000 - 56 000) |
| **4** | less than 5 (< 1.5) | less than 12, 500 (< 28 000) |

### Geological Type

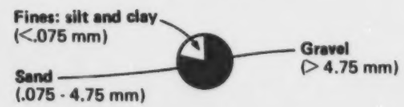
| | | | |
|---|---|---|---|
| **AL** | Older Alluvium | **K** | Kame |
| **E** | Esker | **LB** | Lacustrine Beach |
| **EM** | End Moraine | **LD** | Lacustrine Delta |
| **IC** | Undifferentiated Ice-Contact Stratified Drift | **LP** | Lacustrine Plain |
| | | **OW** | Outwash |
| **ICT** | Ice-Contact Terrace | **WD** | Windblown Forms |

(see Appendix C for descriptions of Geological Types)

### Quality Indicator

| | |
|---|---|
| | If blank, no known limitations present. |
| **C** | Clay and/or silt (fines) present in objectionable quantities. |
| **L** | Deleterious lithologies present. |
| **O** | Oversize particles or fragments present in objectionable quantities. |

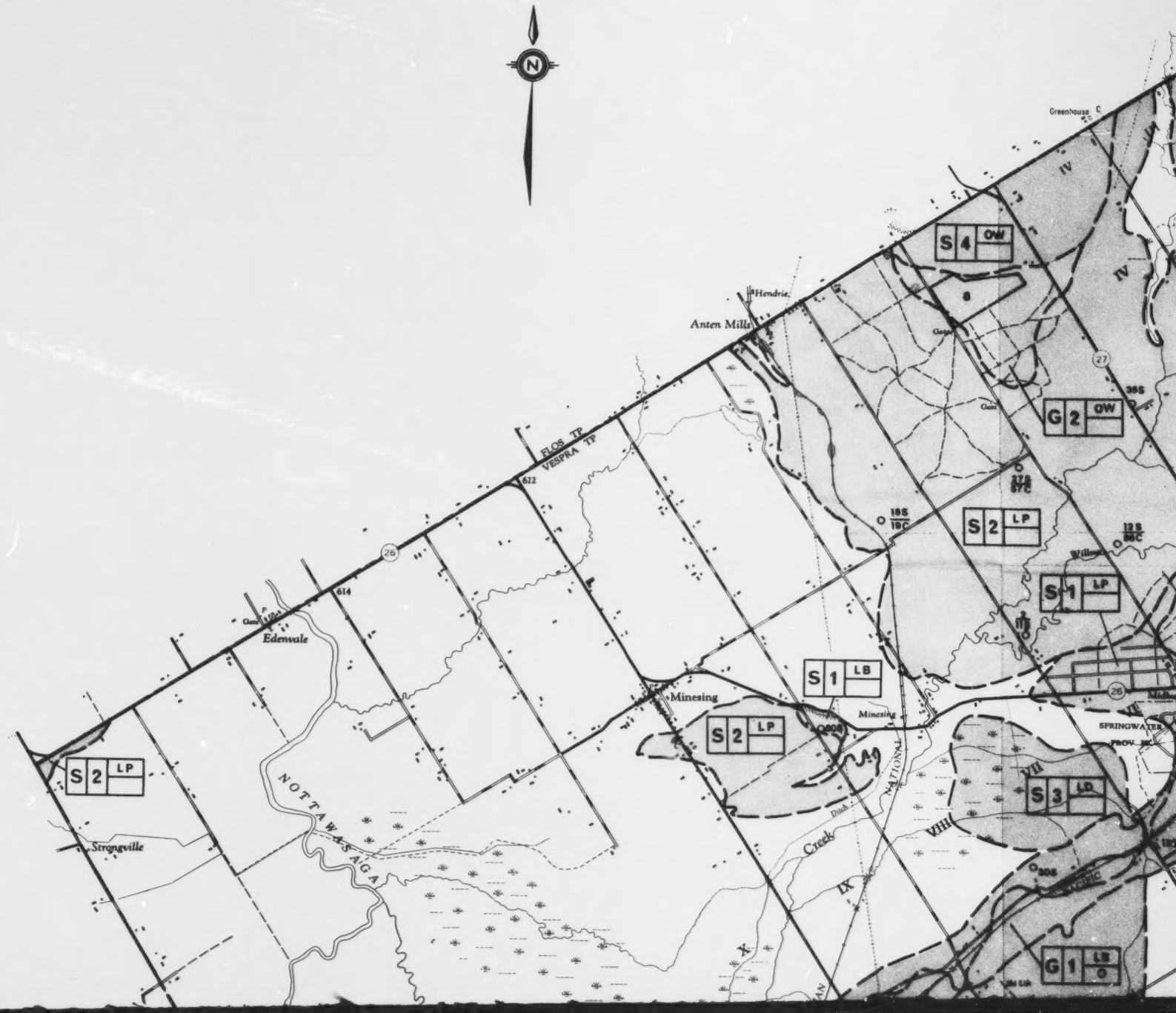
## TEXTURE SYMBOL




The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

## SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.



Ministry of Natural Resources

Ontario

Hon. Alan W. Pope
Minister

J. R. Sloan
Deputy Minister

# ONTARIO GEOLOGICAL SURVEY

## AGGREGATE RESOURCES INVENTORY

# VESPRA TOWNSHIP

## SIMCOE COUNTY

## MAP 1
## DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 31 D/5
31 D/12

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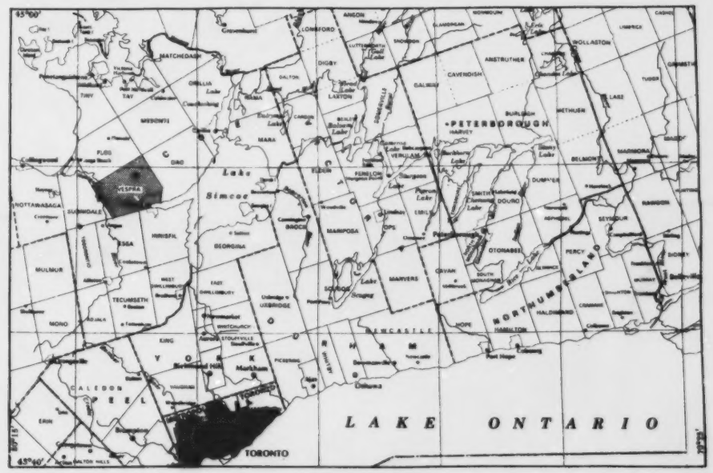



### SYMBOLS

(Some symbols may not apply to this map.)

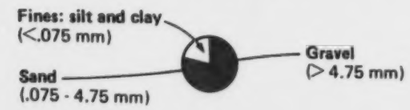
Geological and aggregate thickness boundary. Shading indicates deposit area.

Buried geological and aggregate thickness boundary. Shading indicates deposit area.

Municipal boundary.

L Deleterious lithologies present.
O Oversize particles or fragments present in objectionable quantities.

## TEXTURE SYMBOL




The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

## SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.
Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.
Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.
Test hole data from Aggregate Assessment Office, Ontario Geological Survey, Ontario Ministry of Natural Resources.
Selected drilled water well data from the Ontario Ministry of the Environment.
Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: G. J. Burwasser and S. T. Boyd, 1974.
G. J. Burwasser and B. D. Cairns, 1974.
R. E. Deane, 1950.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 60.

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Issued 1984.

*Information quoted for an individual test hole or pit refers to a specific sample or face. Care should be exercised in extrapolating such information to other parts of the deposit.*

## SYMBOLS

(Some symbols may not apply to this map.)

Geological and aggregate thickness boundary. Shading indicates deposit area.

Buried geological and aggregate thickness boundary. Shading indicates deposit area.

Municipal boundary.

2 — Licenced property boundary; Property number: see Table 2.

3 — Unlicenced sand or gravel pit*; Property number: see Table 2.
*Abandoned pit or wayside pit operating on demand under authority of a permit.

VE-TH-2 — Selected test hole location; Identification number: see Table 7.

6/23 G — Selected drilled water well location; reported thickness of material (in feet); reported type of material (number only - overburden, T - till, G - gravel, S - sand, C - clay, Bk - bedrock).

G 1 IC / C-O — Deposit Symbol: see below.

Texture symbol: see below; see Figures 2a and 2b.

*(Continued at left margin)*

VESPRA

Craighurst
Dalston
Midhurst
Anten Mills
Hendrie
Edenvale
Minesing
Strongville
Greenhouse
Fur Farm
FLOS TP
VESPRA TP
NOTTAWASAGA
Creek
Willow
Little
Lake
SPRINGWATER
PROV. PK
Trans
Gate
Ditch
BM
771
614
622
400
26
27
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
XV
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Minister

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Deputy Minister

# ONTARIO GEOLOGICAL SURVEY
## AGGREGATE RESOURCES INVENTORY

# VESPRA TOWNSHIP
## SIMCOE COUNTY

## MAP 2
## SELECTED SAND AND GRAVEL RESOURCE AREAS

Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 31 D/5
31 D/12

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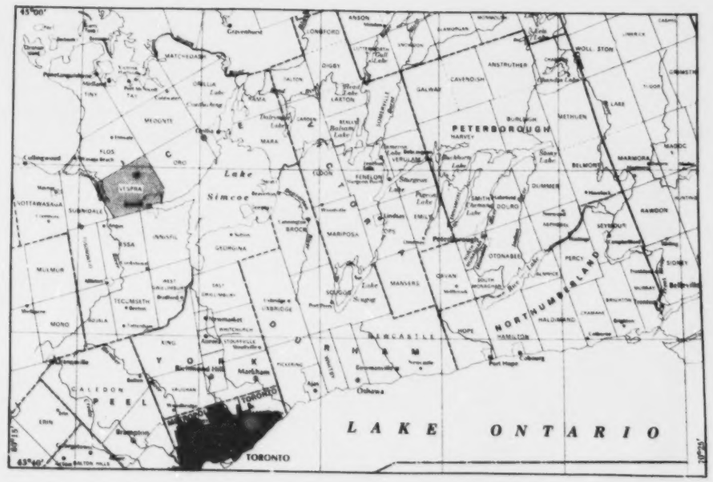


### SYMBOLS

(Some symbols may not apply to this map.)

- Geological and aggregate thickness boundary.
- Buried geological and aggregate thickness boundary.
- Municipal boundary.
- Selected sand and gravel resource area; Primary significance; Deposit number: see Table 3.
- Selected sand and gravel resource area; Secondary

Edenvale

Minesing

Strongville

NOTTAWASAGA

RIVER

Creek

Willow

MINESING

SWAMP

VESPRA TP

SUNNIDALE TP

Cox Line

Midhurst

SPRINGWATER PROV. PK

Midhurst Sp

Trans

Willow

Creek

Little

751

Lake

Ski Lift

Greenhouse

Kilns

Elevator

Airfield

Cundles

Trans

Kilns

Greenhouse

Kilns

BARRIE

Minet Pt

ALLANDALE

Grenfell

INNISFIL

CANADIAN

NATIONAL

TP

90

32

765

ESSA TP

Essa

I II III IV V VI VII VIII IX X XI XII XIII XIV

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 25

## SYMBOLS

(Some symbols may not apply to this map.)

- Geological and aggregate thickness boundary.
- Buried geological and aggregate thickness boundary.
- Municipal boundary.
- Selected sand and gravel resource area; Primary significance; Deposit number: see Table 3.
- Selected sand and gravel resource area; Secondary significance.
- Selected sand and gravel resource area; Tertiary significance.
- 2 — Licenced property boundary; Property number: see Table 2.
- 3 — Unlicenced sand or gravel pit*; Property number: see Table 2. *Abandoned pit or wayside pit operating on demand under authority of a permit.

## SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Geology by: G. J. Burwasser and S. T. Boyd, 1974.
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Issued 1984.

VESPRA

Craighurst
FLOS TP
VESPRA TP
BOBCAYGEON FORMATION
Upper & Middle Members
VERULAM FORMATION
Hendrie
Anten Mills
Dalston
Edenvale
Minesing
Midhurst
Midhurst Sta
SPRINGWATER PROV. PK
Willow Creek
Strongville
NOTTAWASAGA
Little Lake
PACIFIC
NATIONAL
CAN PAC
Greenhouse
Fur Farm
Gate
Ski Lift
Trans
>151
>95
>134
>160
>91
>173
>138
>176
>186
>90
>100
>130
>83
>231
>189
622
614
751
(1337)
(1339)
(1357)
(1359)
(1371)
(1377)
(1385)
BM 737
BM 771
BM 1359
BM 1377
BM 1385
I
II
III
IV
V
VII
VIII
IX
X
26
27
400

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# ONTARIO GEOLOGICAL SURVEY
## AGGREGATE RESOURCES INVENTORY

# VESPRA TOWNSHIP
## SIMCOE COUNTY

## MAP 3
## BEDROCK RESOURCES

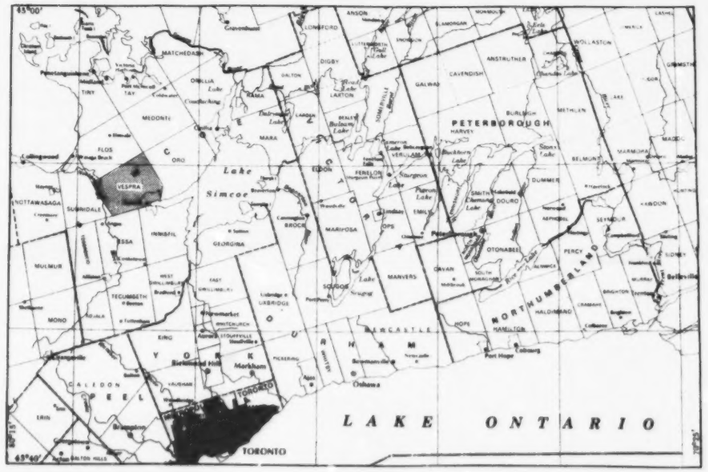
Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 31 D/5
31 D/12

© OMNR-OGS 1984




### LEGEND

**PALEOZOIC**

**ORDOVICIAN**

**MIDDLE ORDOVICIAN**

VERULAM FORMATION
Limestone, shale

BOBCAYGEON FORMATION
Limestone

### SYMBOLS

(Some symbols may not apply to this map.)

- Geological formation boundary.
- Geological formation member boundary.
- Formation thickness boundary (see text).
- 25 — Drift thickness contour: 25 foot (8 m) interval.
- Municipal boundary.
- (2) Selected bedrock resource area; Deposit number: see Table 6.

Edenvale

VERULAM FORMATION

Minesing

Q > 100

Q > 130

Strongville

NOTTAWASAGA

RIVER

Willow

Creek

Duck

NATIONAL

Q > 186

Minesing

VERULAM FORMATION

PACIFIC

Q > 83

Ski Lift

Ski Lift

Bbl 751

CANADIAN

Greenhouse

Kilns

Q > 199

Elevator

Airfield

Q > 108

CANADIAN

VESPRA TP

SUNNIDALE TP

Q > 195

MINESING

SWAMP

VERULAM FORMATION

Grenfell

Q > 150

Essa

Q > 112

VERULAM FORMATION

Q > 75

Power Sta.

VESPRA TP

BSSA TP

Midhurst

Midhurst Sta

SPRINGWATER PROV PK

Q > 90

Trans

Willow

Creek

VERULAM FORMATION

Q > 231

Little

751

Lake

BOBCAYGEON FORMATION

Upper & Middle Members

Q > 189

Cundles

Trans

Airfield

Pipeline

Gas

Kilns

Greenhouse

Q > 160

BARRIE

Minet Pt

ALLANDALE

Q > 115

INNISFIL

NATIONAL

CANADIAN

765

Beav

90

I

II

III

IV

V

VI

VII

VIII

IX

X

XI

XII

XIII

XIV

15

16

26

27

## LEGEND

**PALEOZOIC**

**ORDOVICIAN**

**MIDDLE ORDOVICIAN**

VERULAM FORMATION
Limestone, shale

BOBCAYGEON FORMATION
Limestone

## SYMBOLS

(Some symbols may not apply to this map.)

- Geological formation boundary.
- Geological formation member boundary.
- Formation thickness boundary (see text).
- 25 — Drift thickness contour: 25 foot (8 m) interval.
- Municipal boundary.
- (2) — Selected bedrock resource area; Deposit number: see Table 6.
- Bedrock exposed or near surface; covered by less than 3 feet (1 m) of overburden: see Table 4.
- Bedrock covered by 3 to 25 feet (1 to 8 m) of overburden: see Table 4.
- Bedrock covered by 25 to 50 feet (8 to 15 m) of overburden: see Table 4.
- x — Isolated bedrock outcrop.
- Q2 — Licenced quarry boundary; Property number: see Table 5.
- ● Q3 — Unlicenced quarry*; Property number: see Table 5. *Abandoned quarry or wayside quarry operating on demand under authority of a permit.
- O 28 — Selected drilled waterwell location; reported depth to bedrock (in feet).

## SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Selected drilled water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

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B.A. Liberty, 1969.

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VESPRA